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a Light on this obscure Subject. I am, with very great Respect,

Dear Sir,

Tooting, Feb. 15.
1745-6.

Your faithful Friend,

and obliged humble Servant,

H. Miles.

XVII. *An Account of a Book intituled, De quamplurimis Phosphoris nunc primum detectis Commentarius. Auctore Jac. Barthol. Beccario. Printed in 4to. at Bologna, 1744. Extracted and translated from the Latin by W. Watson, F. R. S.*

Read Feb. 27. 1745-6. THE ingenious Author, in the Work before us, does not treat expressly of those Productions of the chemical Art, which we usually call *Phosphori*, but principally of such Substances, whether natural or artificial, which imbibe the Rays of Light in such Quantities, and in such a Manner, as to appear luminous for a Time, even in absolute Darkness.

Before I enter upon the Subject Matter of this Treatise, I must take notice of the *Apparatus* made use of in these Inquiries. Our Author caused a wooden Box to be made, large enough either to sit in, or stand in upright; yet not so large but he might with Ease be carried to any Place the most convenient

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for his Observations. In this Box was a little Window, in which a cylindrical Tube was fitted so exactly, that no Light could be admitted but through the Tube, in which there was an *Apparatus* so adapted, that the Person within could place any Object proper for Observation in such a Manner, as to receive as much Light as it could contain, and then to turn it instantly towards his Eye, without admiring the least Ray of Light, besides that brought in by the Object. The Inside of this Box must be absolutely dark ; without which Caution many of the Attempts would be unsuccessful ; because the Light in many of the Subjects was neither very lively nor very lasting. Therefore it was necessary also, that the Eyes of the Observer should be as free as possible from the Impressions of former Vision : So that it were proper to make these Observations immediately after Sleep, or to keep the Eye you intend to make use of shut at least half an Hour before you enter the Box. A Proof to know whether your Eye is properly disposed, will be exposing a Piece of white Paper to the Light in the Tube, and then being able to perceive its Form and Colour when turned towards you in the Box.

Our Author divides the *Phosphori* into several Kinds ; some of which shine of themselves naturally, as the Glow-worm and Dates ; or adventitiously, as the Flesh of Animals, which most probably arises from a Degree of Putrefaction, sometimes too slight to be obvious to our Senses. Other Bodies become luminous by Attrition, Heat, the free Access of Air, and, lastly, by imbibing and retaining the Rays of Light. Those Bodies that are luminous by Attrition,
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are amongst others, some Diamonds, and the Hairs of Animals; by Heat, several Sorts of Gems, and Mountain Crystals; from the free Access of Air, the *Phosphori* of *Kraft* and *Homberg*; from the Aspect of Light, the *Bolognian* luminous Stone, the Preparation by *Christian Adolphus Baldwin* of Chalk dissolved in Spirit of Nitre, as well as several others discovered by the late Monsieur *Du Fay*, who found, that whatever Substances would, by Calcination, be converted into a *Calx*, or whose Concrete, from a Solution in the Acid of Nitre, would bear Fire enough to become red-hot, these Bodies were adapted to imbibe and retain Light.

The greatest Number of *Phosphori* are of the last-mention'd Kind, and these are principally the Subjects of this Treatise. Some of these are natural, others artificial; but of these last the Preparation is so slight, as not to change the Nature of their constituent Parts. The natural *Phosphori* are either fossil, vegetable, or animal. The fossil are, though very different in Degree, some Sorts of Earths, white Sand, Lime-stones, *Stalactites*, and several other figured Stones, Island Crystals, Flints, some Species of Agates, white Arsenic; but no sort of Metals, metallic or sulphureous Bodies, as Jet, Amber; except the before-mention'd Arsenic. On the other hand, Salts imbibe Light, provided they are divested of every metallic Principle; otherwise not, though pellucid as possible. For this Reason, none of the Vitriols will imbibe Light; but other Salts will, tho' with a considerable Difference as to Quantity; for *Sal Gem.* and Rock-Salt imbibe very little; Sea-Salt, if dry, and in Crystals, much more; and, in like manner,

manner, *Sal. Ammoniac.*; more yet, *Sal catharticum* and Nitre; weak in the *Natron* of the Ancients, and Alum; but brightest of all in *Borax*.

In the vegetable Kingdom we find very few *Phosphori*; that of dry rotten Wood is weak, and not lasting; it appears chiefly upon the Edges and Inequalities of the Surface. But this is most remarkable in the rotten Wood of the Fir-tree, and some others, where in the dark you see shining Spots as big as Tares; whereas, in full Light, the whole Surface appears alike. Some few Barks are luminous, but not considerably so; but no Fruits, Seeds, or their Meals. Cotton appears very bright, and the Crystals of Tartar; but fine Loaf Sugar appears the most luminous of all, both without and within. Gums and Resins retain no Light.

There is a vast Variety of *Phosphori* in the animal Kingdom, such as the Bones and Teeth; to these may be added the Shells of Fish, Egg-shells, the human *Calculus*, Bezoar, and in whatever Parts of Animals the terrestrial Principle is very predominant. But where there is a considerable Quantity of oily Matter, as in the Hoofs, Horns, and Feathers, no Light is manifest.

The Author, having gone through the natural *Phosphori*, proposes some Queries concerning them; of which the first is, In what and how great a Light the Object ought to be placed? He tried different *Phosphori* in different Degrees of Light, and found them imbibe most Light from the Sun itself; next in Quantity, when the Sky was clear; and the least in foggy Weather. These Experiments should be made in the open Air, and not in a House with the glass Windows shut; because many Bodies appear luminous,

luminous, when the Light has come directly to them, which will not have that Appearance when the Light has passed through the Glass. He lastly tried what Light they would imbibe from very bright Flame, and found, that Alabaster itself, which is saturated more than any Substance by the Sun's Rays, imbibed exceedingly little. The next Query is, how long these Bodies should remain in the Light to be sufficiently saturated? Four or five Seconds were found the utmost Length of Time required for that Purpose. The other Query is, How long the received Light will continue in these *Phosphori*? It does not last the same Time in all; but continues more or less, from 2 Seconds to 8, in proportion to the Strength of the *Phosphorus*, and the Quantity of Light received.

We pass now to those *Phosphori*, which are produced by Art; and, first, to them which are made by the Maceration of Plants alone, and without any Fire; such as Thread, Linen Cloth, but, above all, Paper. The luminous Appearance of this last is greatly increased by Heat. This is confirmed by two Experiments: The first is, by exposing the Paper, spread upon an iron Grate, to the naked Fire, yet not near enough to scorch it, and then laying a warm Brick thereon to retain the Heat; by which means it was observed, that where the Paper was not screened by the iron Grate, it was most luminous; so that, by the Lights and Shades, you might distinguish in the dark the Image of the iron Grate a considerable Time. The other Experiment is the Application of the Paper to a Plate of warm Brass; from which, when in the dark, you might very easily, by its being less luminous,

minous, distinguish the Margin of the Paper, that had not been warmed by the Brads.

The Author proceeds to take notice of those *Phosphori* which become so by the Assistance of Fire. But the Fire here spoken of is not great enough to dissolve their constituent Parts, but only such as may affect the external Parts of their Texture, and that but gently ; so that the Process here mentioned is only drying or roasting. For it is not the watry or the saline Part in Bodies which is torrefied ; but the oleaginous, wherewith many Vegetables, and most Animals, abound.

The white Flesh of Animals, such as that of Chickens, becomes a *Phosphorus* by roasting, as well as the Tendons, and whatever Parts of Animals become glutinous by boiling, such as Carpenter's Glue, Ising-glass; to these may be added Cheese. Bones, tho' they imbibe Light without any Preparation, have that Property in a much greater Degree when burnt, and their luminous Appearance is much more lively. But Roasting has not this Effect upon Feathers, Hoofs, Horns, or Whites of Eggs. The same Operation, which produces several *Phosphori* from the animal Kingdom, gives also several from the vegetable. Thus, by gently toasting, Gums, as Myrrh, Gum Tragacanth, and others, appear luminous, tho' different in Degrees ; and this Light is clear, in proportion to the gentle Evaporation of their aqueous Parts. By this Treatment, Nuts of every Kind, Pulse, Corn, Coffee-Berries, Meal, Bread, and Wafers, also become *Phosphori*. Turpentine, Amber, and some Resins, require more Fire before they imbibe Light ; so that you must divest them of their Acid, and their light

light ethereal Oil, to make them appear luminous. But here great Care must be taken that they boil no longer than from being white they turn yellow; for if you proceed longer, your Labour is lost.

It is necessary that you should be acquainted, that those *Phosphori*, which are produced by Torrefaction, soon lose their Power, which, perhaps, neither Time, nor a thorough Dissolution of their Parts, can deprive the natural ones of. In general, as long as the *Phosphori*, gained by Torrefaction, preserve their Power, their Light is more sharp and striking, but the natural, more weak. But those that are gained by Calcination, and *Baldwyn's Phosphorus*, seem to possess both the striking Light of those gained by Torrefaction. and the weaker Light of the natural *Phosphori*: The last they preserve a long time, but the former is lost by degrees much sooner. The well calcin'd Ashes of Plants, or rather their terrestrial Parts remaining after the Solution of their fixed Salts by washing, and neutral Salts, continue *Phosphori* after many Years. So that, as far as we can judge, the luminating Power which is gained by Calcination, tho' not so intense, continues perpetual; whereas that gained by Torrefaction always decreases, and in a very little while is no longer visible. Some even, by this Method, continue to imbibe Light much longer than others. Gum *Arabic*, which continues longest, lasts six Days; Bread, not one; and Coffee, only a few Minutes. However, at any time, by a fresh Torrefaction, you may recover these languid *Phosphori*; in which Property they have great Likeness to the *Bolognian Stone*, and other *Phosphori* prepared by Art. The *Phosphori* gained by Torrefaction, as well

well as that of *Bolognia*, will not imbibe Light, while they are warm; and this last does not appear so luminous when first prepared, as when it has been so some time.

The natural *Phosphori* do not differ only in the before-mention'd Particulars, but also in the Colour of the Light itself. The Light of the natural generally appears either perfectly bright, or somewhat inclining to yellow: The artificial produces a red, and sometimes a brown Light; but there are some Exceptions to both these Rules. From these different Appearances, the Author conjectures, that there are two Sorts of Fire arising from different Principles; viz. that in torrefied Substances, from a sulphureous, and that of the natural, from a terrestrial Principle.

In observing a Piece of *Lapis Tutiae*, which was rough and unequal on its convex Side, smooth and somewhat polished on the concave; he found, to his Surprize, that the rough Side was luminous, and the smooth one not. He was very desirous of investigating the Cause of this Appearance. He remember'd that some polish'd Marbles did not imbibe Light, or very little, and that at their Edges; but, having lost their Polish, they did admit and retain it. He therefore conjectures, that Bodies, according to the Disposition of their Surfaces for the Reflection of the Light, either suffer or prevent its Entrance into them. If this Position holds good in the Reflection, why should it not with regard to the Refraction? Our Author produces two Experiments, which he apprehends not foreign to the present Purpose; but is yet making others, for his further Satisfaction. He exposed a glass Bottle full of Well-Water to the Light;

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and, as soon as possible, observed it in the dark. As he expected, it imbibed no Light. Upon pouring into it some Oil of Tartar, it became turbid and whitish, from the Well-Water being usually impregnated with calcarious Matter. Upon observing it then in the dark, after having been exposed as before, it retained enough of a pale Light to distinguish the Shape of the Bottle. In a Bottle of Rain-Water he dissolved some Talc; which Stone, by rubbing, will dissolve in Water as Salts do, without rendering it opaque; to this Solution he added Oil of Tartar, and this Mixture was luminous as the preceding. He therefore concludes, that so long as earthy Corpuscles are very small, separate, and agreeing in their Surfaces with the Water in which they float, they readily transmit the Light they receive; for which Reason it is impossible they should retain Light enough to appear luminous in the dark. But, by the Affusion of the saline Principle, the earthy Corpuscles unite with the Water and Salt; and from the Union of these Principles the Mixture grows thick, whereby the ready Transmission of Light is prevented; so that, if this Mixture is without Colour, or any thing metallic, the Light will be stopped long enough to be visible in the dark. But if, instead of Oil of Tartar, you add Sugar of Lead, the Mixture will be turbid, but retain no Light. In these two Experiments the Water becomes a *Phosphorus*.

Gems, Crystals, and Glass, whether whole, or powder'd ever so fine, retain no Light; so that neither their Transparency nor Whiteness contribute to their becoming luminous in the dark. Of several Diamonds, in all Appearance perfectly the same, some

were very luminous, others not at all. Of many opaque Substances, whether rough, polished, or finely powder'd, some were luminous, others not. So that it appears, that not only the external, but the internal Texture of Bodies also, may conduce sometimes to their being luminous.

From the preceding Experiments, the Author is led to make some Inquiries into the Cause of this luminous Appearance; and takes notice, that almost all Bodies, by a proper Treatment, have that Power of shining in the dark, which, at first, was supposed to be the Property of one, and afterwards only of a few. How this is brought about, is not very easy to solve. If we suppose with some (to which our Author, in several Passages of this Work, seems not averse), that the Light from a luminous Body enters and abides in the *Phosphori*, we shall find somewhat new to admire in Light itself. It is no new Opinion, that this Fluid consists of very fine Particles, which are continually darted forth from a luminous Body, in all Directions, with a very great Velocity: But it has by nobody been laid down hitherto, that these Particles are not dissolved by the Violence of their Agitation, nor dispersed, nor immediately cease to exist; but subsist still, and adhere to what Bodies come in their Way, as Heat does, and are the Causes of Odours. If therefore the Particles of Light are not dissolved as soon as they are emitted from a radiant Body, but continue some time, what else is required, but that we allow its Atmosphere to every lucid Appearance? If the *Phosphori* shine with a borrowed Light, but not with their own, and that only when put in Motion, and fired by the Rays of a shining Body, which some

some Experiments seem to confirm, then other new Doctrines will arise. There must be then a hidden, a secret Principle in Bodies, to be lighted up by this most subtle Fire. There will be in the Universe a certain perpetual Fire from these *Phosphori*; the Matter of which, tho' constantly dissipated by burning, does not waste enough to be obvious to our Senses.

I cannot conclude my Extract of this Author, without mentioning, that his Work is the Result of a great Variety of very ingenious Observations, and of Experiments made with the utmost Accuracy; to which I may add, that where-ever he makes any Conjecture concerning their Causes, he does it with all possible Decency, and Submission to the Judgment of the Learned.

XVIII. *A Letter from the Rev. Dr. Miles,
F. R. S. to Mr. Baker, F. R. S. concerning
the Electricity of Water.*

Dear Sir,

*Read Feb. 27.
1745-6.* I BEGIN with a Resolution to be merciful, and hope to keep it, especially as I persecute you again so soon; and indeed the true Reason of my doing it now, is that this might reach you before I have the Favour of another from you, as it relates to an Article in my last *.

I this Afternoon, on reflecting afresh on Monsieur L'Allamand's Experiment †, resolved to make the fol-

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* p. 79. *supra.*

† p. 59. *supra.*